<u>**Claims**</u>

I claim:

1. An apparatus for measuring, as a function of incident beam geometry, the energy distribution emitted from a sample comprising:

a) a source for producing a substantially collimated source radiation beam directed along an optical path;

b) a paraboloidal reflector, having an optical axis disposed parallel to the optical path, positioned to intercept the collimated radiation beam at a first location on the reflector and to focus the intercepted beam to form an incident beam that strikes the sample at a selected sample location with a selected angle of incidence, whereupon the radiation from the incident beam is redirected by the sample into an emitted radiation distribution at least a portion of which is intercepted and reflected by the reflector; and

c) a detector for receiving the emitted radiation distribution reflected by the reflector.

2. The apparatus according to claim 1 wherein the source comprises a beam steerer for directing the radiation beam to determine the position of the first location on the reflector.

3. The apparatus according to claim 2 wherein the beam steerer comprises a translator for moving the source with respect to the reflector.

4. The apparatus according to claim 1 comprising a source aperture disposed along the optical path between the source and the reflector, the source aperture defining the width of the beam intercepted by the reflector from the source.

5. The apparatus according to claim 4 comprising a translator for moving the source aperture with respect to the reflector whereby the position of the first location is determined.

6. The apparatus according to claim 4 wherein the source aperture comprises a variable aperture.

7. The apparatus according to claim 4 wherein the source aperture comprises a liquid crystal shutter.

8. The apparatus according to claim 4 wherein the source aperture comprises a circular aperture.

9. The apparatus according to claim 4 wherein the source aperture comprises a central obscuration.

10. The apparatus according to claim 1 wherein the source comprises a radiation emitter and a collimator for collimating the radiation emitted by the radiation emitter.

11. The apparatus according to claim 1 wherein the reflector is a circular paraboloid.

12. The apparatus according to claim 1 wherein the reflector is a half-silvered reflector.

13. The apparatus according to claim 1 wherein the optical axis of the reflector is substantially parallel to a plane which contains the surface of the sample.

14. The apparatus according to claim 1 wherein the reflector is a concave paraboloid.

15. The apparatus according to claim 1 wherein the reflector intercepts the entire emitted radiation distribution.

16. The apparatus according to claim 1 wherein the reflector is an off-axis paraboloid.

17. The apparatus according to claim 1 comprising a beam splitter disposed along the optical path between the source and the reflector, for receiving the source radiation beam and directing the source radiation beam to the first location on the reflector.

18. The apparatus according to claim 1 wherein the emitted radiation distribution comprises at least one radiation ray and the detector comprises a detection plane for receiving the radiation ray, wherein the location at which the radiation ray strikes the detection plane corresponds to an angle of incidence with which the radiation ray struck the reflector.

19. The apparatus according to claim 18 wherein the detector comprises an imaging system for directing the radiation ray to the detection plane.

20. The apparatus according to claim 18 wherein the detector comprises an array of radiation detecting elements disposed along the detection plane, wherein the radiation ray strikes a respective radiation detecting element, the respective element associated with the angle of incidence with which the respective radiation ray struck the reflector.

21. The apparatus according to claim 20 wherein the detection array comprises a two-dimensional array of radiation detecting elements.

22. The apparatus according to claim 21 wherein the location of a respective radiation detecting element corresponds to a respective angle of incidence at which a respective ray, received by the respective element, struck the reflector.

23. The apparatus according to claim 22 wherein the detector comprises an imaging system for directing the respective radiation ray to the respective radiation detection plane.

24. The apparatus according to claim 20 wherein the detector comprises a beam expander disposed between the reflector and the radiation detecting element.

25. The apparatus according to claim 1 wherein detector comprises an orthographic lens having an aperture stop disposed proximate to the focal point of the lens.

26. The apparatus according to claim 1 wherein the detector comprises at least one of a linear polarizer, an elliptical polarizer, a circular polarizer, an optical retarder, or spectral filter.

27. The apparatus according to claim 1 wherein the detector comprises a polarizer for blocking a component of the emitted radiation distribution having the same polarization state as that of the source radiation beam.

28. The apparatus according to claim 1 wherein the detector comprises a spectral filter for blocking a component of the emitted radiation distribution within the spectral range of the source radiation beam.

29. The apparatus according to claim 1 wherein the detector comprises a spectral filter for transmitting a component of the emitted radiation distribution within the spectral range of the source radiation beam.

30. The apparatus according to claim 1 comprising a detector translator for moving the detector with respect to the reflector whereby varying portions of the emitted radiation distribution are received by the detector.

31. The apparatus according to claim 30 comprising a detector aperture disposed between the detector and the reflector to intercept the emitted radiation distribution, to pass a portion of the emitted radiation distribution to the detector.

32. The apparatus according to claim 31 wherein the detector translator translates the detector and the detector aperture, the detector and detector aperture disposed in fixed relation to one another.

33. The apparatus according to claim 31 wherein the detector aperture comprises a variable aperture.

34. The apparatus according to claim 31 wherein the detector aperture comprises a liquid crystal shutter.

35. The apparatus according to claim 31 wherein the detector aperture comprises a circular aperture.

36. The apparatus according to claim 31 wherein the detector aperture comprises a central obscuration disposed within the emitted radiation distribution to block a specularly reflected component of the emitted radiation distribution from transmission to the detector.

37. The apparatus according to claim 1 wherein the focal point of the reflector is located proximate to the selected sample location.

38. The apparatus according to claim 37 wherein the focal point is located within the volume of the sample.

39. The apparatus according to claim 37 wherein the focal point is located proximate to the surface of the sample.

40. The apparatus according to claim 1 comprising a sample aperture disposed proximate to the focal point of the reflector.

41. The apparatus according to claim 1 comprising a reflector translator for moving the reflector with respect to the sample.

42. The apparatus according to claim 1 comprising a sample translator for moving the sample with respect to the reflector.

43. The apparatus according to claim 1 wherein the source comprises at least one of a linear polarizer, an elliptical polarizer, a circular polarizer, an optical retarder, or spectral filter.

44. The apparatus according to claim 1 wherein the source emits electromagnetic radiation.

45. The apparatus according to claim 1 wherein the source emits the collimated source radiation in an axial plane which contains the optical axis.

46. The apparatus according to claim 45 wherein the reflector is an elliptical paraboloidal reflector.

47. The apparatus according to claim 1 wherein the detector comprises at least one of a charge coupled device, a focal plane array, colorimeter, or spectrophotometer.

48. An apparatus for measuring, as a function of incident beam geometry, the energy distribution emitted from a sample comprising:

a) a source for producing a substantially collimated source radiation beam directed along an optical path;

b) a paraboloidal reflector, having an optical axis disposed parallel to the optical path, positioned to intercept the collimated radiation beam at a first location on the reflector and to focus the intercepted beam to form an incident beam that strikes the sample at a selected sample location with a selected angle of incidence, whereupon the radiation from the incident beam is redirected by the sample into an emitted radiation distribution at least a portion of which is intercepted and reflected by the reflector;

c) a detector for receiving the emitted radiation distribution reflected by the reflector;

d) a beam steerer for directing the radiation beam to the first location on the reflector; and

e) a detector translator for moving the detector with respect to the reflector whereby varying portions of the emitted radiation distribution are received by the detector.

49. The apparatus according to claim 48 wherein the beam steerer comprises a translator for moving the source with respect to the reflector.

50. The apparatus according to claim 48 comprising a source aperture disposed along the optical path between the source and the reflector, the source aperture defining the width of the beam intercepted by the reflector from the source.

51. The apparatus according to claim 50 wherein the beam steerer moves the source aperture with respect to the reflector.

52 The apparatus according to claim 51 wherein the source aperture comprises a variable aperture.

53. The apparatus according to claim 52 wherein the source aperture comprises a liquid crystal shutter.

54. The apparatus according to claim 48 wherein the source comprises a radiation emitter and a collimator for collimating the radiation emitted by the radiation emitter.

55. The apparatus according to claim 48 wherein the reflector is a circular paraboloid.

56. The apparatus according to claim 48 wherein the beam steerer comprises a rotatable aperture disk

57. The apparatus according to claim 48 wherein the optical axis of the reflector is substantially parallel to a plane which contains the surface of the sample.

58. The apparatus according to claim 48 wherein the reflector is a concave paraboloid.

59. The apparatus according to claim 48 wherein the reflector intercepts the entire emitted radiation distribution.

60. The apparatus according to claim 48 wherein the reflector is an off-axis paraboloid.

61. The apparatus according to claim 48 comprising a beam splitter disposed along the optical path between the source and the reflector, for receiving the source radiation beam and directing the source radiation beam to the first location on the reflector.

62. The apparatus according to claim 48 wherein the emitted radiation distribution comprises at least one radiation ray and the detector comprises a detection plane for receiving the radiation ray, wherein the location at which the radiation ray strikes the detection plane corresponds to an angle of emission with which the radiation ray was emitted from the sample.

63. The apparatus according to claim 62 wherein the detector comprises an imaging system for directing the radiation ray to the detection plane.

64. The apparatus according to claim 62 wherein the detector comprises an array of radiation detecting elements disposed along the detection plane, wherein the radiation ray strikes a respective radiation detecting element, the respective element associated with the angle of emission with which the radiation ray was emitted from the sample.

65. The apparatus according to claim 64 wherein the detection array comprises a two-dimensional array of radiation detecting elements.

66. The apparatus according to claim 65 wherein the location of a respective radiation detecting element corresponds to a respective angle of emission with which the radiation ray, received by the respective element, was emitted from the sample.

67. The apparatus according to claim 66 wherein the detector comprises an imaging system for directing the respective radiation ray to the respective radiation detection plane.

68. The apparatus according to claim 64 wherein the detector comprises a beam expander disposed between the reflector and radiation detecting element.

69. The apparatus according to claim 48 wherein detector comprises an orthographic lens having an aperture stop disposed proximate to the focal point of the lens.

70. The apparatus according to claim 48 wherein the detector comprises at least one of a linear polarizer, an elliptical polarizer, a circular polarizer, an optical retarder, or spectral filter.

71. The apparatus according to claim 48 wherein the detector comprises a polarizer for blocking a component of the emitted radiation distribution having the same polarization state as that of the source radiation beam.

72. The apparatus according to claim 48 wherein the detector comprises a spectral filter for blocking a component of the emitted radiation distribution within the spectral range of the source radiation beam.

73. The apparatus according to claim 48 wherein the detector comprises a spectral filter for transmitting a component of the emitted radiation distribution within the spectral range of the source radiation beam.

74. The apparatus according to claim 48 comprising a detector aperture disposed between the detector and the reflector to intercept the emitted

radiation distribution, to pass a portion of the emitted radiation distribution to the detector.

75. The apparatus according to claim 74 wherein the detector translator translates the detector and the detector aperture, the detector and detector aperture disposed in fixed relation to one another.

76. The apparatus according to claim 74 wherein the detector aperture comprises a variable aperture.

77. The apparatus according to claim 74 wherein the detector aperture comprises a liquid crystal shutter.

78. The apparatus according to claim 74 wherein the detector aperture comprises a circular aperture.

79. The apparatus according to claim 74 wherein the detector aperture comprises a central obscuration disposed within the emitted radiation distribution to block a specularly reflected component of the emitted radiation distribution from transmission to the detector.

80. The apparatus according to claim 48 wherein the focal point of the reflector is located proximate to the selected sample location.

81. The apparatus according to claim 80 wherein the focal point is located within the volume of the sample.

82. The apparatus according to claim 80 wherein the focal point is located proximate to the surface of the sample.

83. The apparatus according to claim 48 comprising a reflector translator for moving the reflector with respect to the sample.

84. The apparatus according to claim 48 comprising a sample translator for moving the sample with respect to the reflector.

85. The apparatus according to claim 48 wherein the source comprises at least one of a linear polarizer, an elliptical polarizer, a circular polarizer, an optical retarder, or spectral filter.

86. The apparatus according to claim 48 wherein the source emits electromagnetic radiation.

87. The apparatus according to claim 48 wherein the source emits the collimated source radiation in an axial plane that contains the optical axis.

88. The apparatus according to claim 87 wherein the reflector is an elliptical paraboloidal reflector.

89. The apparatus according to claim 48 wherein the detector comprises at least one of a charge coupled device, a focal plane array, colorimeter, or spectrophotometer.

90. A method for measuring, as a function of incident beam geometry, the energy distribution emitted from a sample comprising the steps of:

a) directing a beam of substantially collimated radiation along an optical path;

b) receiving the collimated radiation beam by a paraboloidal reflector, having an optical axis disposed parallel to the optical path, and focusing the received beam to form an incident beam that strikes the sample at a selected sample location with a selected angle of incidence, whereupon the radiation from the incident beam is redirected by the sample into an emitted radiation distribution;

c) intercepting, with the reflector, at least a portion of the emitted radiation distribution and directing such portion of the emitted radiation distribution as an emitted radiation beam;

d) detecting the emitted radiation beam so that a measurement can be made of the intensity of the emitted radiation beam as a function of an angle of emission of the emitted radiation beam and as a function the angle of incidence of the incident beam.

91. The method of claim 90 wherein step of directing the substantially collimated beam comprises the step of directing the collimated

radiation beam to the first location on the reflector with a beam steerer to determine the angle of incidence.

92. The method of claim 91 wherein step of directing the substantially collimated beam comprises the step of defining the width of the beam received by the reflector from the source by varying the diameter of a source aperture disposed between the source and the reflector.

93. The method of claim 90 wherein step of directing the substantially collimated beam includes the step of directing the beam to the first location on the reflector using a beam splitter disposed along the optical path between the source and the reflector.

94. The method of claim 90 wherein step of intercepting the emitted radiation distribution includes intercepting the entire emitted radiation distribution with the reflector.

95. The method of claim 90 wherein step of detecting the emitted radiation beam includes the step of determining the angle of emission with which the emitted radiation beam was emitted from the sample.

96. The method of claim 90 wherein step of detecting the emitted radiation beam includes the step of receiving at least one radiation ray of the emitted radiation beam at a detection plane of the detector, and determining,

from the location at which the radiation ray strikes the detection plane, the angle of emission with which the detected emitted radiation beam was emitted from the sample.

97. The method of claim 90 wherein step of detecting the emitted radiation beam includes the step of moving the detector with respect to the reflector whereby varying portions of the emitted radiation distribution are received by the detector.

98. The method of claim 97 wherein step of detecting the emitted radiation beam comprises the step of defining the width of the emitted radiation beam detected by the detector by varying the diameter of a detector aperture disposed between the detector and the reflector.

99. The method of claim 98 wherein step of detecting the emitted radiation beam includes the step of moving the detector and detector aperture with respect to the reflector, whereby varying portions of the emitted radiation distribution are received by the detector.

100. The method of claim 90 wherein step of detecting the emitted radiation beam includes the step of blocking a specularly reflected component of the emitted radiation distribution from transmission to the detector using a central obscuration of a detector aperture.

101. The method of claim 90 wherein step of intercepting the emitted radiation distribution includes the step of focusing the incident beam proximate to the selected sample location.

102. The method of claim 90 wherein step of intercepting the emitted radiation distribution includes the step of focusing the incident beam within the volume of the sample.

103. The method of claim 90 wherein step of intercepting the emitted radiation distribution includes the step of focusing the incident beam proximate to the surface of the sample.

104. The method of claim 90 comprising the step of moving the reflector with respect to the sample.

105. An apparatus for measuring, as a function of incident beam geometry, the energy distribution emitted from a sample comprising:

a) a source for producing a substantially collimated source radiation beam directed along an optical path;

b) a paraboloidal reflector, having an optical axis disposed parallel to the optical path, positioned to intercept the collimated radiation beam at a first location on the reflector and to focus the intercepted beam to form an incident beam that strikes the sample at a selected sample location with a selected angle of incidence, whereupon the radiation from the incident beam is redirected by

the sample into an emitted radiation distribution at least a portion of which is intercepted and reflected by the reflector;

c) a detector for receiving the emitted radiation distribution reflected by the reflector;

d) a source aperture disposed along the optical path between the source and the reflector;

e) a beam steerer for moving the source aperture with respect to the reflector to direct the source radiation beam to the first location on the reflector; and

f) a beam splitter disposed along the optical path between the source aperture and the reflector, for receiving the source radiation beam and directing the source radiation beam to the reflector.

106. The apparatus according to claim 105 wherein the emitted radiation distribution comprises at least one radiation ray and wherein the detector comprises an array of radiation detecting elements disposed along the detection plane, wherein the radiation ray strikes a respective radiation detecting element, the respective element associated with the angle of emission with which the radiation ray was emitted from the sample.

107. The apparatus according to claim 106 wherein detector comprises an orthographic lens having an aperture stop disposed proximate to the focal point of the lens.

108. An apparatus for measuring, as a function of incident beam geometry, the energy distribution emitted from a sample comprising:

a) a source for producing a substantially collimated source radiation beam directed along an optical path;

b) a paraboloidal reflector, having an optical axis disposed parallel to the optical path, positioned to intercept the collimated radiation beam at a first location on the reflector and to focus the intercepted beam to form an incident beam that strikes the sample at a selected sample location with a selected angle of incidence, whereupon the radiation from the incident beam is redirected by the sample into an emitted radiation distribution at least a portion of which is intercepted and reflected by the reflector;

c) a detector for receiving the emitted radiation distribution reflected by the reflector; and

d) a beam steerer comprising at least one rotatable aperture disk for directing the radiation beam to the first location on the reflector through the rotation of the disk.

109. The apparatus according to claim 108 wherein the aperture disk comprises multiple apertures.

110. The apparatus according to claim 108 wherein the beam steerer comprises a multi-aperture disk and a slit-aperture disk registered to the multi-aperture disk along a common axis of rotation.

111. The apparatus according to claim 110 wherein the apertures of multi-aperture disk are disposed in a spiral pattern.